

## KION MultiGas 2000 Service Manual



## Notes

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# 1. Important

## General

- This Service Manual is intended to give service personnel sufficient knowledge about the KION MultiGas 2000 (KMG 2000) to be able to diagnose any possible problem or failure and to identify which part or component that causes the problem or failure. The description is limited to a level, which allows the service personnel to track problems down to parts that are found in the spare part list.
- This Service Manual is also intended to give information how to perform preventive maintenance and to make functional checks and calibrations.
- Documentation for the KMG 2000 consists of:
  - SC 7000 / SC 9000XL – User's guide
  - KION – Operating Manual
  - KION – Service Manual
  - KION MultiGas 2000 – Service Manual
  - KION MultiGas 2000 – Installation Instructions
  - KION MultiGas 2000 – Spare Parts List
- The SC 7000 / SC 9000XL – User's guide and the KION – Operating Manual are indispensable complements to the Service Manual for proper servicing.

Text inside a box is used to highlight important information.

- In addition to the Important information given here and in the related documents, always pay attention to applicable local and national regulations.
- Responsibility for the safe functioning of the equipment reverts to the owner or user in all cases in which service or repair has been done by a non-professional or by persons who are not employed by or authorized by Siemens, and when the equipment is used for other than its intended purpose.
- Data on internal pressures are given in Pa (bar). Airway pressures are given in cm H<sub>2</sub>O (Pa).
 

1 hPa = 1 mbar	1 mbar = 1 hPa
1 kPa = 10 mbar	1 mbar = 0.1 kPa
1 kPa = 0.01 bar	1 bar = 100 kPa
1 kPa ≈ 10 cm H <sub>2</sub> O	1 cm H <sub>2</sub> O ≈ 0.1 kPa
1 kPa ≈ 0.01 at	1 at ≈ 100 kPa
1 kPa ≈ 0.01 kgf/cm <sup>2</sup>	1 kgf/cm <sup>2</sup> ≈ 100 kPa
1 kPa ≈ 0.01 kp/cm <sup>2</sup>	1 kp/cm <sup>2</sup> ≈ 100 kPa
1 kPa ≈ 0.145 psi	1 psi ≈ 6.9 kPa


## Symbols used in this manual

- **ESD sensitive components** – Make sure to take precautions to avoid damaging ESD sensitive components. 
- **Special waste** – Make sure to discard disposables and replaced parts according to local regulations and in an environmentally acceptable way. 
- **Technical training** – Refers to the Technical training supplied by Siemens. 
- **Service contract** – Refers to the Service contract supplied by Siemens. 

## Abbreviations used in this manual

- **KMG 2000** – KION MultiGas 2000.
- **KION Display** – Siemens Patient Care Monitors, e. g. SC 7000 or SC 9000XL.

## Installation

- Only personnel trained and authorized by Siemens shall be permitted to install the KMG 2000. The installation and handing-over procedures are described in the KION MultiGas 2000 – Installation Instructions. 

## Functional check

- After any installation, maintenance or service intervention in the KMG 2000, perform a "Functional verification". Refer to chapter Service procedures, section Functional verification in this Service Manual.

# 1. Important

## Hazard notices

- Before disassembling or assembling the KION and/or the KMG 2000, make sure that the:
  - Gas supply is disconnected.
  - Mains power cable is disconnected.
  - KION power switch is set to Off. If the power switch is set to Standby or On, the internal battery will supply power to the PC boards.
  - Internal battery is disconnected when working inside the Power & Communication interface.
  - The system is cleaned according to instructions in the KION – Operating Manual, chapter Routine cleaning.
- With power supply connected to the KION System, there are energized electrical components inside the unit. All personnel must exercise extreme caution if fault tracing or adjustments are performed with power supply connected.

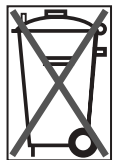
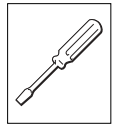
## Warnings

- The KMG 2000 must not be used with flammable anesthetic agents.
- Water emptied from the water trap should be disposed of in accordance with local regulations for contaminated and biologically hazardous fluids.
- The water trap should be disposed of in accordance with local regulations for contaminated and biologically hazardous items.
- The evacuated gas must be handled in a suitable manner to prevent hazardous levels of anesthetic gases to be built-up in the ambient air.
- Analyzer performance is likely to be degraded in the presence of operating electrosurgical or diathermy equipment.



## Service

- The KMG 2000 must be serviced at regular intervals by personnel trained and authorized by Siemens. Any maintenance or service must be noted in a log book.
- Preventive maintenance must be performed at least once every year as long as the unit is not used more than normal. Normal operation is estimated to correspond to approx. 5.000 hours of operation. Details are found in this Service Manual, chapter "Preventive maintenance".
- It is recommended that maintenance and service is done as a part of a service contract with Siemens.
- All disposable parts shall be discarded according to local regulations and in an environmentally acceptable way.
- When working with ESD sensitive components, always use a grounded wrist band and a grounded work surface. Adequate service tools must always be used.

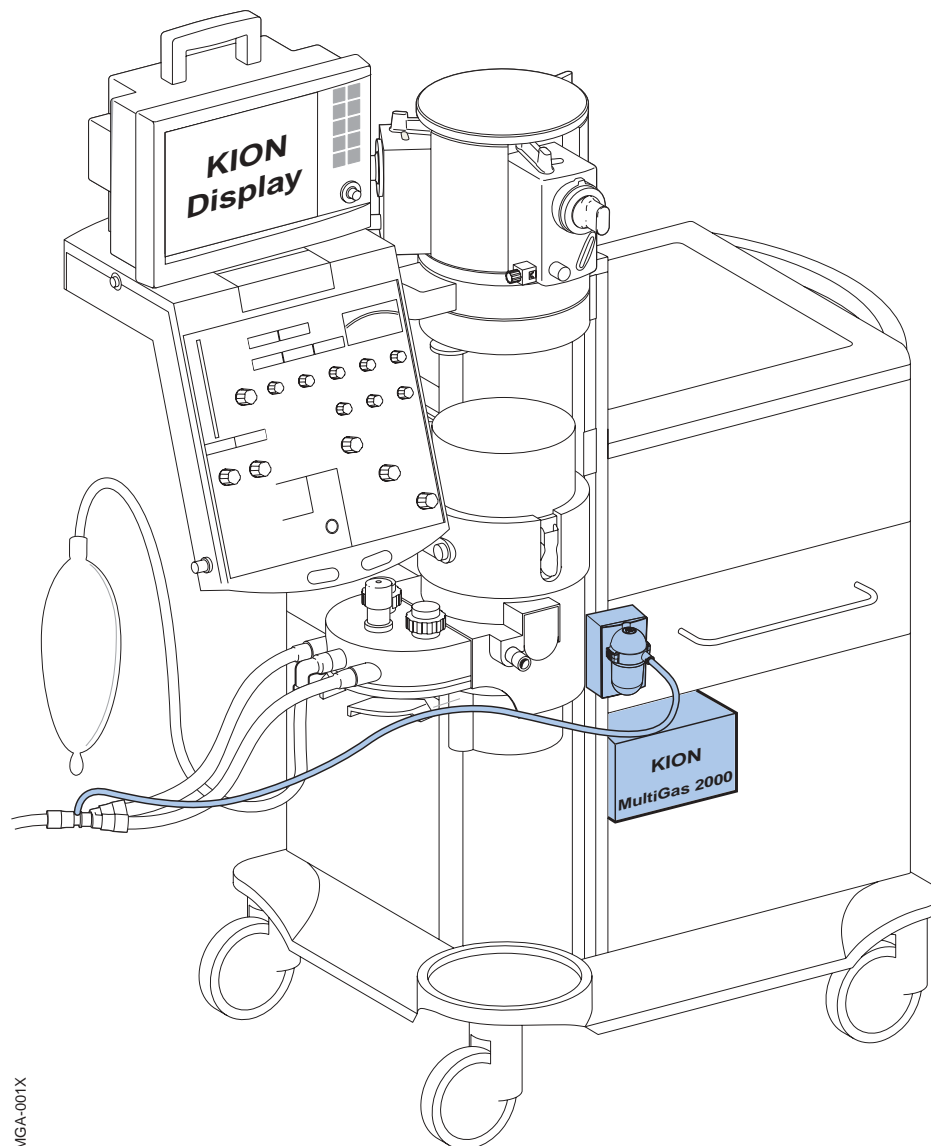


## To the responsible service personnel

- The contents of this document are not binding. If any significant difference is found between the product and this document, please contact Siemens for further information.
- We reserve the right to modify products without amending this document or advising the user.
- Only personnel trained and authorized by Siemens shall be permitted to perform installation, service or maintenance of the KION and/or the KMG 2000. Only Siemens genuine spare parts must be used. PC boards (spare parts) must always be kept in a package for sensitive electronic devices. Siemens will not otherwise assume responsibility for the materials used, the work performed or any possible consequences of same.



## 2. Introduction



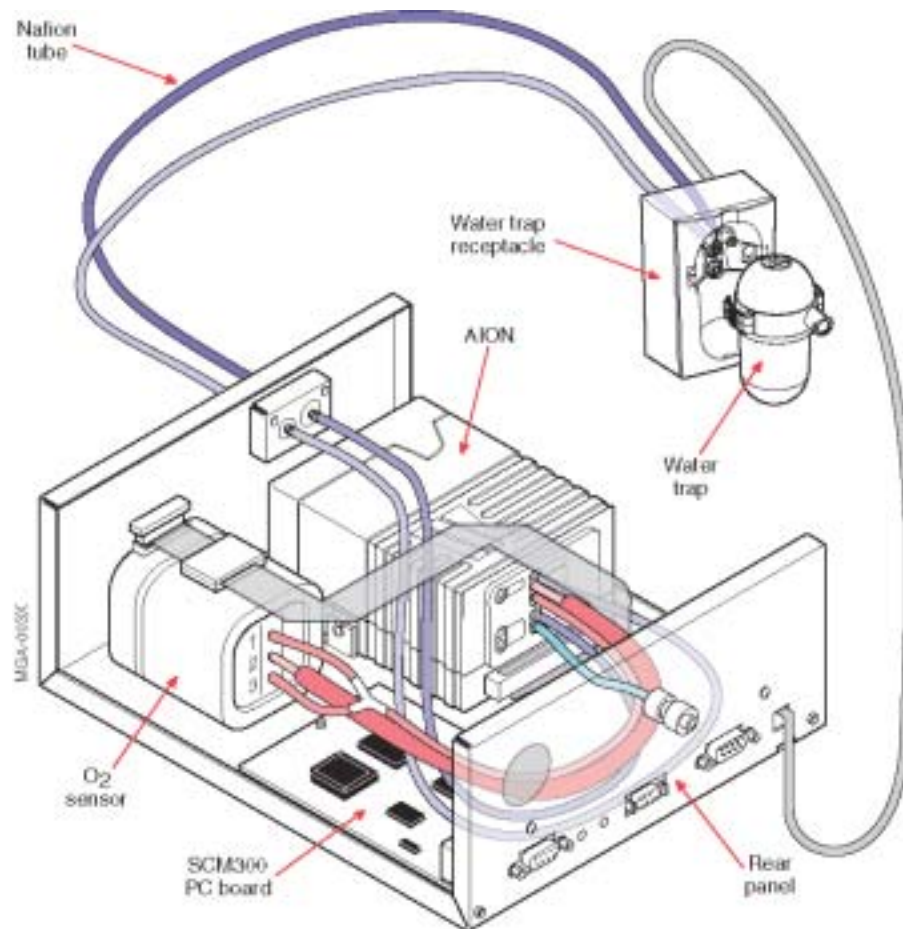
### 2.1 General description

The KION MultiGas 2000 (KMG 2000) is intended for integration in the KION Anesthesia System. The KMG 2000 delivers gas measurement data to be shown on the KION Display.

The KMG 2000 is a side-stream multigas analyzer intended to monitor respiratory and anesthetic gases sampled from the breathing circuits of adult, pediatric and neonatal patients. The gases measured are O<sub>2</sub>, CO<sub>2</sub>, N<sub>2</sub>O, Halothane, Enflurane, Isoflurane, Sevoflurane and Desflurane in any combination.

All gases in the gas sample, except O<sub>2</sub>, are identified and measured by an infrared sensor. O<sub>2</sub> is identified and measured by a paramagnetic O<sub>2</sub> sensor.

The information created by the KMG 2000 is delivered to the KION Display where the information is calculated and shown.



## 2.2 Mechanical overview

### 2.2.1 Water trap

The DRYLINE™ water trap consists of two parts, a filter housing with hydrophobic anti-bacterial filter and a container for separated waste.

### 2.2.2 Water trap receptacle

The water trap is connected to the water trap receptacle. Switches on the water trap receptacle detects that a water trap is connected. The sample gas flow is routed from the water trap receptacle to the KMG 2000 via a Nafion™ tube.

### 2.2.3 AION

The AION™ is the gas measuring unit. It contains the following modules:

- **Pneumatic Module:** Interconnection between the different parts of the gas sampling system. Includes two solenoid valves; the zero calibration valve (ZCV) and the purge flow valve (PFV).
- **Gas Measurement Bench (GMB):** Identifies and measures the gases CO<sub>2</sub>, N<sub>2</sub>O, Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane.
- **Pump Module:** Creates and controls the gas sampling flow.

- **AION PC board:** Integrated in the AION base module. Contains CPU, EEPROM and software. Controls the gas sampling system and performs calculations from the measured parameters.

### 2.2.4 O<sub>2</sub> sensor

The paramagnetic O<sub>2</sub> sensor identifies and measures the O<sub>2</sub> concentration in the gas sample.

### 2.2.5 SCM300 PC board

The SCM300 PC board is an interconnection between modules within the KMG 2000 and includes also all external electrical connectors. The RS232 protocol converters are located on this PC board.

A metal shield covering the external connectors mounted on the SCM300 PC board protects the interior from electromagnetic interference from the outside.

### 2.2.6 Rear panel

The evacuation outlet connector and all external electrical connectors are mounted on the rear panel.

## 2.3 Functional principles

This description refers to the functional block diagram, see chapter Diagrams.

### 2.3.1 Gas sampling system

The KMG 2000 samples a continuous gas flow from the patient breathing circuit to measure concentrations and to identify gases in the breathing gas. A gas pump creates and controls the gas flow through the sampling system.

From the gas sampling line, the gas enters the water trap where water droplets and secretions are separated from the flow and collected in the water trap container.

In the water trap, the gas flow is divided in two parts:

- The sampling gas flow, approx. 90% of the total gas flow.
- The purge gas flow, approx. 10% of the total flow.

Both gas flows pass a filter inside the water trap. This filter protects the sampling system from condensed water, secretions, bacteria and other kind of contamination.

The sampling gas flow passes:

- The Nafion tube where the moisture content and the temperature in the sampled gas are equalized to that of the ambient air.
- The Zero Calibration Valve (ZCV). Zero calibrations are performed automatically at regular intervals.
- The Gas Measurement Bench (GMB). The CO<sub>2</sub>, N<sub>2</sub>O and anesthetic agents are identified and measured in the Gas Measurement Bench (GMB).
- The O<sub>2</sub> Sensor where the O<sub>2</sub> content is identified and measured.

The purge gas flow passes:

- The Purge Flow Valve (PFV). The PFV automatically flushes the sampling system if the sampling gas flow is obstructed.

Both gas flows are now mixed and connected to the pump. After passing the pump, the gas flow is routed back to the patient breathing circuit via the evacuation outlet.

### 2.3.2 Data communication

Analog signals from the GMB and the O<sub>2</sub> sensor are converted to digital signals by the AION CPU. This digital information is delivered to the KION Display via the Protocol Converter (PrC).

### 2.3.3 Control system

The pump and thus the gas sampling flow rate is controlled by information from the water trap receptacle. Switches in the water trap receptacle identify if a water trap is connected.

Calibration information is stored separately in EEPROMs in the GMB, in the pump and in the AION PC board.

Software upgrades/updates of the AION-SW and the PrC-SW, can be performed via a PC connected to P1. The switches SW1 and SW2 select the flash memory to be upgraded/updated.

The 24 V DC power is supplied via connector P2 from the KION power supply. Both the SCM300 PC board and the AION PC board have separate DC/DC converters and 5 V stabilizers.



### 3. Description of functions

This description in this chapter also refers to the functional block diagram, see chapter Diagrams.

#### 3.1 Water trap

The DRYLINE™ water trap protects the gas analyzer system from condensed water, secretions, bacterial contamination and dust. It consists of two parts, a filter housing with hydrophobic anti-bacterial filter and a container for separated waste.

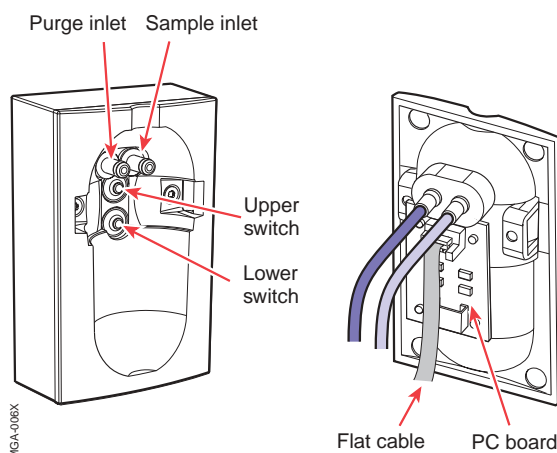
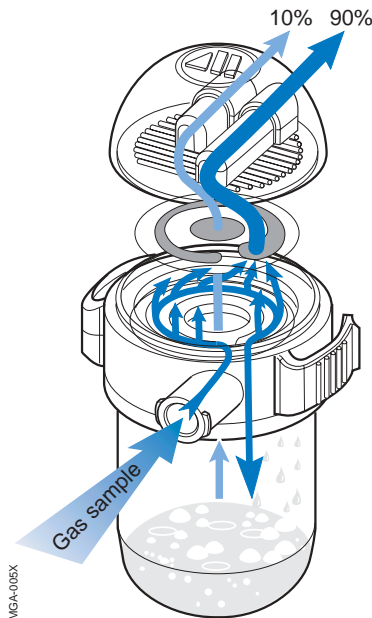
The filter housing has one gas sample inlet to be connected to the sampling tube.

In the water trap, the sampling flow is divided in two parts:

- Sampling gas flow (approx. 90%).
- Purge gas flow (approx. 10%).

There are two outlets in the filter housing, one for each gas flow.

The DRYLINE water trap to be used with the KMG 2000 is designed for a sampling flow of 120–200 ml/min. For further information, see Water trap receptacle below.



#### 3.2 Water trap receptacle

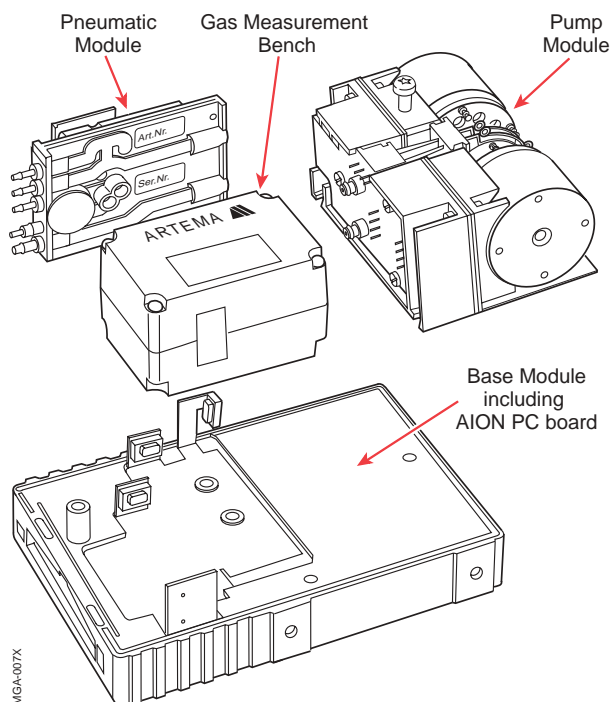
The water trap is connected to the water trap receptacle. There are two gas connections on the receptacle; one for the sampling gas flow and one for the purge gas flow.

The two electrical switches on the water trap receptacle detects if a water trap is present and identifies the version of the connected water trap. The water trap receptacle is designed to identify two different water trap versions:

- The high-flow water trap. This version of the water trap is to be used with the KMG 2000. The water trap activates both switches. The sampling flow is by default set to 200 ml/min, but can be changed to 120 ml/min via the KION Display, refer to the User's manual.
- The low-flow water trap. This version of the water trap is not used in this application. It activates only the lower switch. This low-flow water trap is intended to be used in applications where the sampling gas is not routed back to the patient circuit.

If no water trap is connected or if a water trap without container is connected, both switches are inactive. The pump, and thus the gas flow through the KMG 2000, is automatically stopped to prevent contamination.

The control signal cable from the water trap receptacle PC board is connected to the SCM300 PC board via connector P4a.



### 3.3 Nafion tube

The Nafion™ tube equalizes the moisture content and the temperature in the sampled gas to that of the ambient air. This is to reduce the influence on the measurements from humidity and to prevent from water condensation inside the sampling system.

### 3.4 AION

The AION is the gas measuring unit. It is a complete unit and must not be disassembled. The following modules are included in the AION:

- Pneumatic Module
- Gas Measurement Bench
- Pump Module
- Base Module including AION PC board

#### 3.4.1 Pneumatic Module

The pneumatic module interconnects the pump, the gas measurement bench and the O<sub>2</sub> sensor. There are two solenoid valves in the pneumatic module; the zero calibration valve and the purge flow valve.

**Zero Calibration Valve (ZCV):** To establish a gas zero concentration reference, ambient air is routed through the Gas Measurement Bench via the Zero Calibration Valve.

The automatic zero calibration of the AION will be performed:

- During warm-up
- At a temperature change >1 °C (in the GMB)
- Every 4 hours
- At gas span calibration.

**Purge Flow Valve (PFV):** During normal sampling condition there is always a small purge flow, approx. 10% of the total flow, through the KMG 2000. This purge flow is created by the purge flow restrictor.

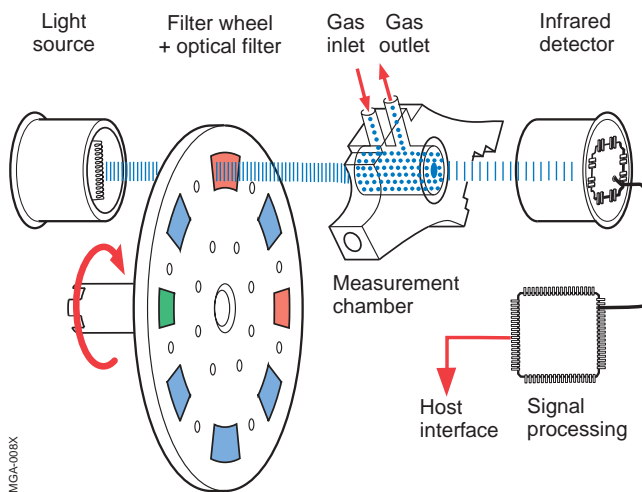
If there is an obstruction in the sampling line, this will be detected by the flow sensor in the pump as a decreased flow.

If the total flow from the two water trap outlets drops below 40 ml/min for more than one second, the forced purge flow-function is activated during 12 seconds. This forced purge flow is created by the Purge Flow Valve connected in parallel with the purge flow restrictor. The forced purge flow forces water and secretions in the sampling line into the water trap container. The forced purge flow is routed from the water trap directly to the pump and out through the evacuation outlet. It will not pass the Gas Measurement Bench or the O<sub>2</sub> Sensor.

If the total flow remains below the limit value, the forced purge flow-function will be repeated up to four times until further forced purge cycles are inhibited. The purge function is automatic and is not possible to start manually.

The KMG 2000 Service Software is required to:

- Perform an O<sub>2</sub> sensor calibration if the O<sub>2</sub> sensor and/or the AION has been replaced.
- Update the configuration stored in the AION EEPROM if the AION unit has been replaced. This is done to secure traceability and to allow correct revision number to be shown on the KION Display.



### 3.4.2 Gas Measurement Bench

The  $\text{CO}_2$ ,  $\text{N}_2\text{O}$  and anesthetic agents are identified and measured in the Gas Measurement Bench (GMB).

The GMB consists of an IR light source, a rotating filter wheel with optical filters connected to a DC motor, the gas measurement chamber and an IR light detector.

The measurement of  $\text{CO}_2$ ,  $\text{N}_2\text{O}$  and the anesthetic agents in the sampling gas is based on the fact that the different gas components absorb infrared light at specific wavelengths. The filter wheel has eight optical filters to allow an accurate analysis of any mixture of these gases.

As  $\text{O}_2$  does not absorb infrared light to the same extent as other breathing gases,  $\text{O}_2$  is measured by the separate  $\text{O}_2$  Sensor. However, the presence of  $\text{O}_2$  causes some interference and information from the  $\text{O}_2$  Sensor is used to compensate for that interference.

The GMB also includes a PCB with a EEPROM and components for pressure and temperature measurements. Factory calibration data are stored in the EEPROM and the gas calibration data is updated during the gas span calibration.

### 3.4.3 Pump Module

The double-action membrane pump has a built-in flow control with its own flow sensor. The delivered flow is very stable with minimal flow variations. The design of the pump makes it very reliable with no maintenance necessary.

The water trap to be used with the KMG 2000 sets the default sampling flow rate to 200 ml/min. The sampling flow rate can be changed to 120 ml/min via the KION Display, refer to the User's manual.

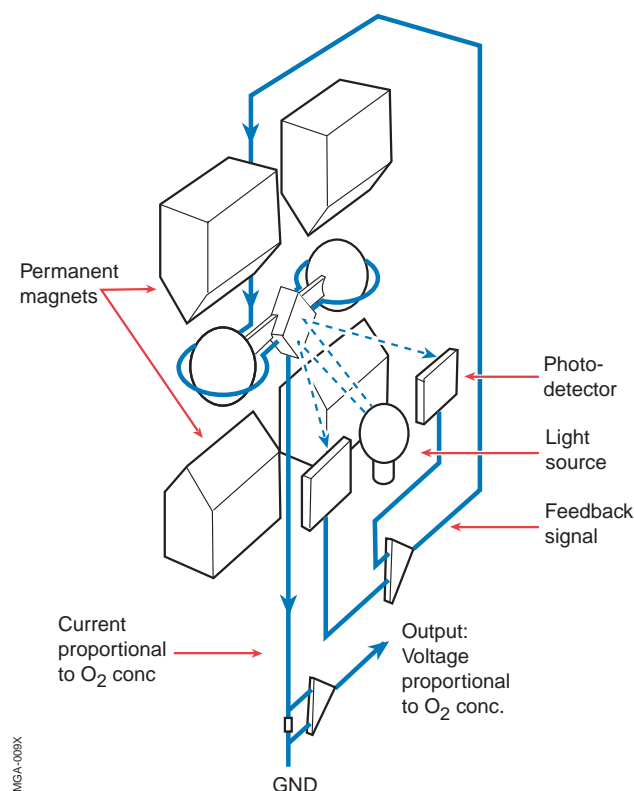
During the forced purge flow, the pump capacity will be increased to create the forced purge flow. This will not change the sampling flow rate.

### 3.4.4 AION PC board

The AION module has a PC board with CPU and memory functions. This PC board controls the gas sampling system and performs calculations from the measured parameters. The analog signals from the GMB and from the  $\text{O}_2$  sensor are converted to digital signals in the AION CPU.

The AION-SW, stored in a flash memory, can be updated/upgraded. Refer to chapter Service procedures, section Software installation.

The AION PC board has a 5 V DC/DC converter for its internal power supply and for  $\text{O}_2$  sensor power supply.



### 3.5 O<sub>2</sub> sensor

The O<sub>2</sub> sensor is a paramagnetic sensor that measures the O<sub>2</sub> content in the sampled gas mixture. The sensor output is one volt for a concentration of 100% oxygen.

O<sub>2</sub> is distinguished from most other common gases by its paramagnetic properties. This fact is used by the paramagnetic O<sub>2</sub> sensor, which has two nitrogen-filled glass spheres mounted on a strong rare metal taut-band suspension. This assembly is suspended in a symmetrical non-uniform magnetic field. In the presence of paramagnetic O<sub>2</sub>, the glass spheres are pushed further away from the strongest part of the magnetic field. The strength of the torque acting on the suspension is proportional to the O<sub>2</sub> concentration.

A feedback system creates a current that balances the torque acting on the suspension assembly. The feedback current is directly proportional to the partial pressure of O<sub>2</sub> in the sample. A voltage output is derived that is proportional to the current, which in turn is proportional to the O<sub>2</sub> concentration.

The O<sub>2</sub> sensor has no consumable parts and has a consistent performance over time. It requires no reference gas for zero calibration and has no interference from other respiratory gases.

The O<sub>2</sub> sensor delivers analogue information to the AION CPU via the P6/P5 connectors on SCM300 PC board. The analogue information is converted to digital and delivered to KION, together with gas measurement information from AION.

AION uses the O<sub>2</sub> concentration data to compensate for the O<sub>2</sub> interference on the gas measurements performed by AION.

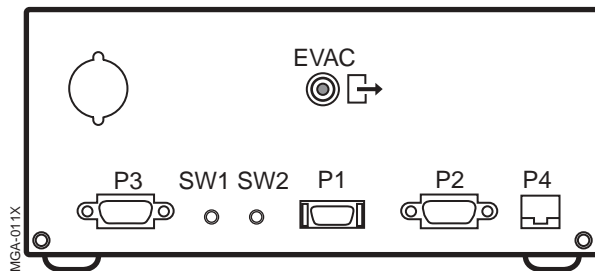
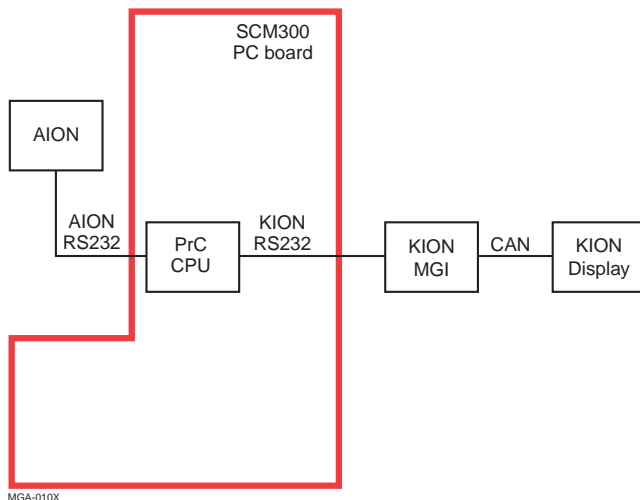
The O<sub>2</sub> sensor is powered with +5 VDC from AION via P5/P6 on SCM300 PC board.

The KMG 2000 Service Software is required to:

- Adjust the potentiometers on the O<sub>2</sub> sensor. If the KMG 2000 Service Software is not used, the measurement accuracy of the KMG 2000 will be outdated.
- Perform an O<sub>2</sub> sensor calibration if the O<sub>2</sub> sensor and/or the AION has been replaced.
- Update the O<sub>2</sub> sensor serial number stored in AION EEPROM if the O<sub>2</sub> sensor has been replaced.

The KMG 2000 Service Software is required to:

- Update the SCM300 H/W revision and S/W version stored in AION EEPROM if the SCM300 board has been replaced.



#### P1, Software installation and service com. connector

No.	Name	Source	Description
1	DGnd	—	Digital ground
2	Vpos	Host	Positive power supply
3	DataTd	KMG	AION transmit data
4	Vpos	Host	Positive power supply.
5	ServiceTd	KMG	AION and SCM service transmit data
6	Vpos	Host	Positive power supply
7	nc	—	No connection
8	nc	—	No connection
9	PGnd	—	Power ground
10	DGnd	—	Digital ground
11	PGnd	—	Power ground
12	DataRd	Host	AION receive data
13	PGnd	—	Power ground
14	ServiceRd	Host	AION and SCM service receive data

#### P2, Power supply connector

No.	Name	Source	Description
1	Vpos	Host	Positive power supply
2	Vpos	Host	Positive power supply
3	nc	—	No connection
4	PGnd	—	Power ground
5	PGnd	—	Power ground
6	PGnd	—	Power ground
7	PGnd	—	Power ground
8	Vpos	Host	Positive power supply
9	Vpos	Host	Positive power supply

### 3.6 SCM300 PC board

The electrical connectors and switches accessible on the rear panel are mounted on the SCM300 PC board. The PC board is also an interconnection board between AION, the O<sub>2</sub> sensor and the water trap receptacle. For further information regarding connectors, refer to section Rear panel below and to the Functional block diagram.

The KMG 2000 is powered by 24 V DC from the KION power supply. The SCM300 PC board has a 5 VDC voltage converter for its internal electrical circuits.

The Protocol Converter PrC CPU on the SCM300 PC board converts the gas measurement information from the AION RS232 protocol to the RS232 protocol used in KION. The KION MGI (inside KION) converts the KION RS232 protocol to the CAN protocol used by the KION Display.

The PrC-SW, stored in a flash memory, can be updated/upgraded. Refer to chapter Service procedures, section Software installation.

### 3.7 Rear panel

The rear panel of the KMG 2000 has the following connectors and switches:

P1: Software and service communication connector.

P2: Power supply connector.

P3: Monitor communication connector.

P4: Water trap receptacle connector.

SW1: Switch with integrated LED, used when installing PrC-SW.

SW2: Switch with integrated LED, used when installing AION-SW.

EVAC: Evacuation outlet connector for sampling gas.

#### P3, Monitor communication connector

No.	Name	Source	Description
1	CanL	Host & MGI	Differential CAN-bus low line
2	CanL	Host & MGI	Differential CAN-bus low line
3	CanH	Host & MGI	Differential CAN-bus high line
4	CanH	Host & MGI	Differential CAN-bus high line
5	Gnd	—	Ground
6	Td	PrC	RS232 Transmitted data
7	Cts	Host or MGI	RS232 Clear to send
8	Rts	PrC	RS232 Request to send
9	Rd	Host or MGI	RS232 Received data
10	nc	—	No connection
11	TdLoop	MGI	RS232 Transmitted data (loop back)
12	RtsLoop	PrC	RS232 Request to send (loop back)
13	CtsLoop	MGI	RS232 Clear to send (loop back)
14	RdLoop	PrC	RS232 Received data (loop back)
15	nc	—	No connection

#### P4, Water trap receptacle connector

- 1 Vwt – Positive voltage. Short circuit protected with 50 ohm. Not used.
- 2 Wt Type – Water trap type. Low Connection to ground for high flow and open circuit for low flow.
- 3 WtMounted – Water trap mounted. Connection to ground when water trap mounted.
- 4 DGnd – Digital ground

## 4. Disassembly and assembly

### 4.1 General

All service associated with the KMG 2000, including disassembly and assembly, is done in accordance with this Service Manual.

Only personnel trained and authorized by Siemens shall be permitted to perform installation, service or maintenance of the KION and/or the KMG 2000.



### 4.2 Handling PC boards

The PC board contains components that are highly sensitive to static electricity. Those who come into contact with circuit boards containing sensitive components must take certain precautions to avoid damaging the components (ESD protection).



When working with ESD sensitive components always use a grounded wristband and grounded work surface. Adequate service tools must also be used. PC boards (spare or exchange parts) must always be kept in protective packaging for sensitive electronic devices.

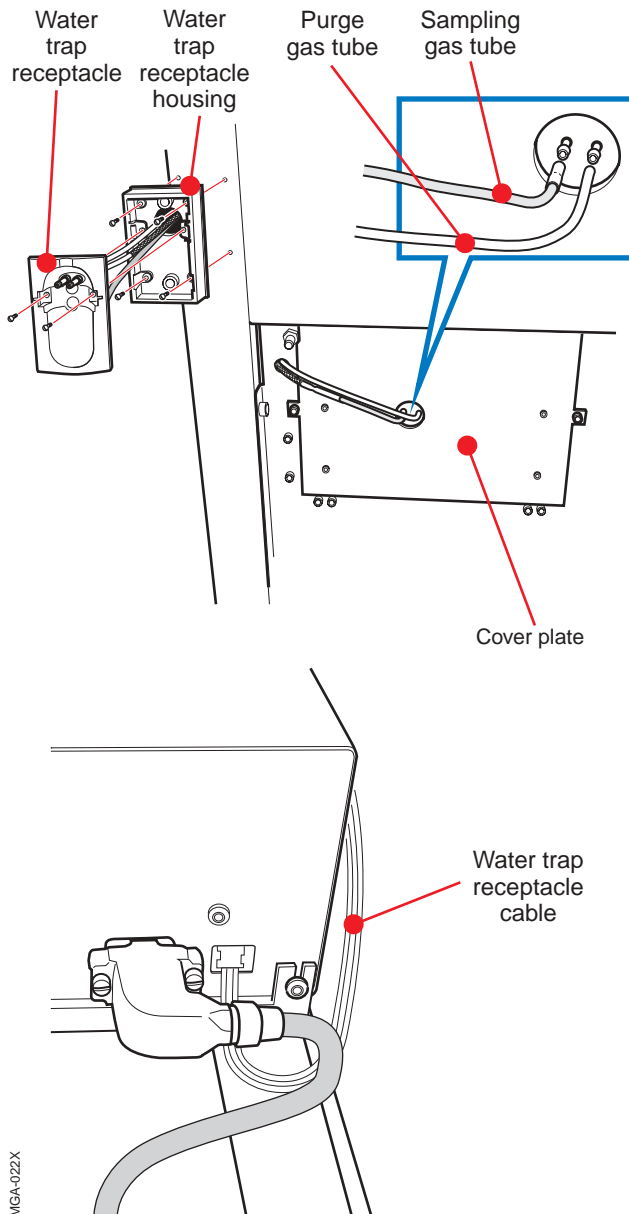
PC boards must not be inserted or removed while power is applied to the PC boards.

Remove and insert the PC boards very carefully to avoid damage to the connectors.

### 4.3 Tools

- Standard service tools
- Torx wrench size T6
- Knife / scalpel





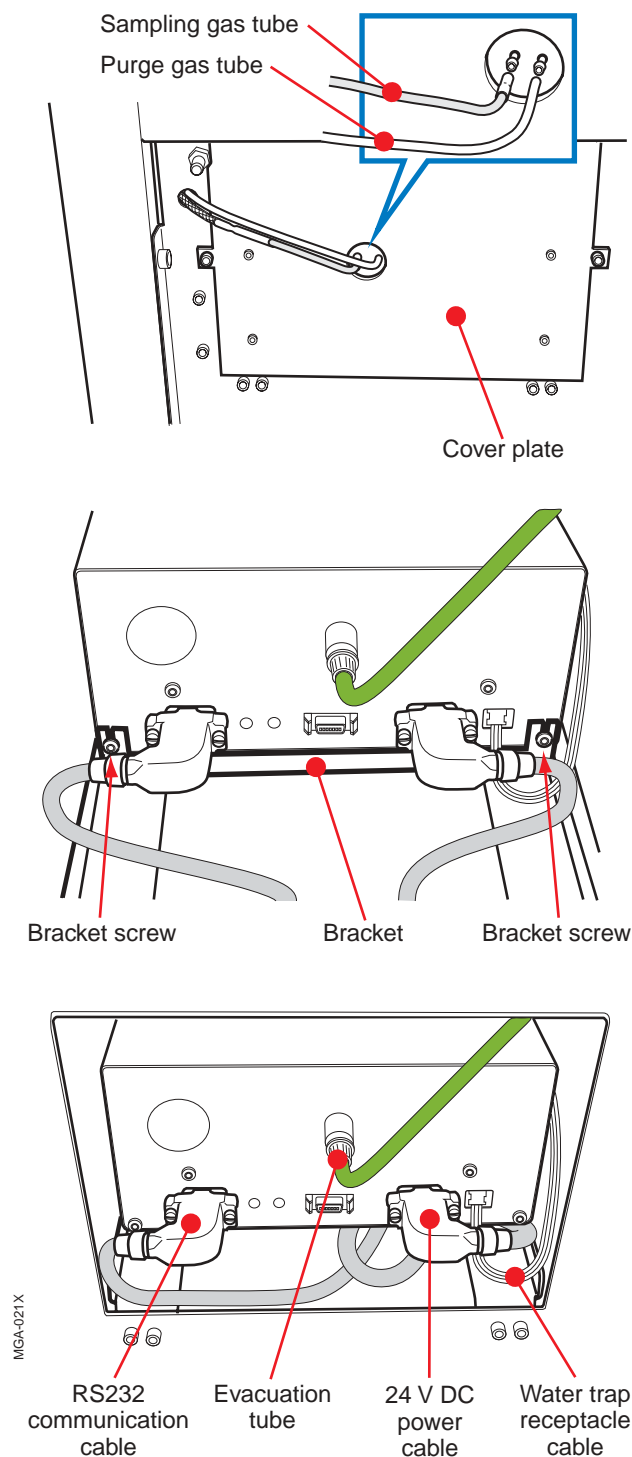
## 4.4 Water trap receptacle on KMG 2000

### 4.4.1 Disassembly

1. Remove trolley covers on KION to make the multigas analyzer compartment accessible.
2. Disconnect the sampling gas and purge gas tubes from the KMG 2000.  
To make the water trap receptacle replacement easier, it is recommended to remove the compartment cover plate. If so, remove the four screws securing the KMG 2000 to the cover plate and the two screws securing the cover plate to KION. Lift off the cover plate.
3. From the rear side of KION, remove the multigas analyzer compartment cover plate and disconnect the water trap receptacle cable from KMG 2000.
4. Attach a "pull wire", e. g. a 50 cm long flexible cable, to the old water trap receptacle tubing. Use tape to attach the pull wire.
5. Remove the small Torx screws securing the water trap receptacle to its housing.
6. Carefully pull out the tubing, cable and pull wire through the hole in the column.
7. Remove the water trap receptacle housing from the column.

### 4.4.2 Assembly

1. Mount the water trap receptacle housing on the column.
2. Attach the tubing and the cable of the new receptacle to the pull wire. Pull through the hole in the water trap receptacle housing and through the hole in the column.
3. Route the cable to the rear of KION through the cable tie in the upper part of the multigas analyzer compartment. Connect the water trap receptacle cable to KMG 2000.
4. Route the tubing through the hole in the rail adjacent to the KMG 2000.
5. Re-mount the multigas analyzer compartment cover plates.
6. Connect the sampling gas tube to the left inlet and the purge gas tube to the right inlet on the KMG 2000.
7. Remount the trolley covers on KION.
8. Perform a Functional verification. Refer to chapter Service procedures.



## 4.5 Removal and installation of KMG 2000 in KION

### 4.5.1 Removal

1. Remove trolley covers on KION to make the multigas analyzer compartment accessible.
2. Disconnect the sampling gas tube and purge gas tube from the KMG 2000.
3. Remove the four screws securing the KMG 2000 to the cover plate and the two screws securing the cover plate to KION. Lift off the cover plate.
4. From the rear side of KION, remove the multigas analyzer compartment cover plate.
5. Loosen the two bracket screws, remove the bracket and pull out the KMG 2000.
6. Disconnect the:
  - Water trap receptacle cable
  - Evacuation tube
  - RS232 communication cable
  - 24 V DC power cable.
7. Lift off the KMG 2000.

### 4.5.2 Assembly

1. Place the KMG 2000 in position in the multigas analyzer compartment.
2. Connect the:
  - Water trap receptacle cable
  - Evacuation tube
  - RS232 communication cable
  - 24 V DC power cable.
3. Mount the bracket screws loosely.
4. Slide the KMG 2000 into correct position inside the multigas analyzer compartment.
5. Mount the bracket. Do not tighten the bracket screws yet.
6. Mount the cover plate:
  - Tighten the four screws securing the KMG 2000 to the cover plate.
  - Tighten the two screws securing the cover plate to the KION.
7. Connect the sampling gas tube to the left inlet and the purge gas tube to the right inlet on the KMG 2000.
8. On the rear side of KION:
  - Squeeze the KMG 2000 and the bracket together and tighten the two bracket screws.
  - Mount the cover plate.
9. Remount the trolley covers on KION.



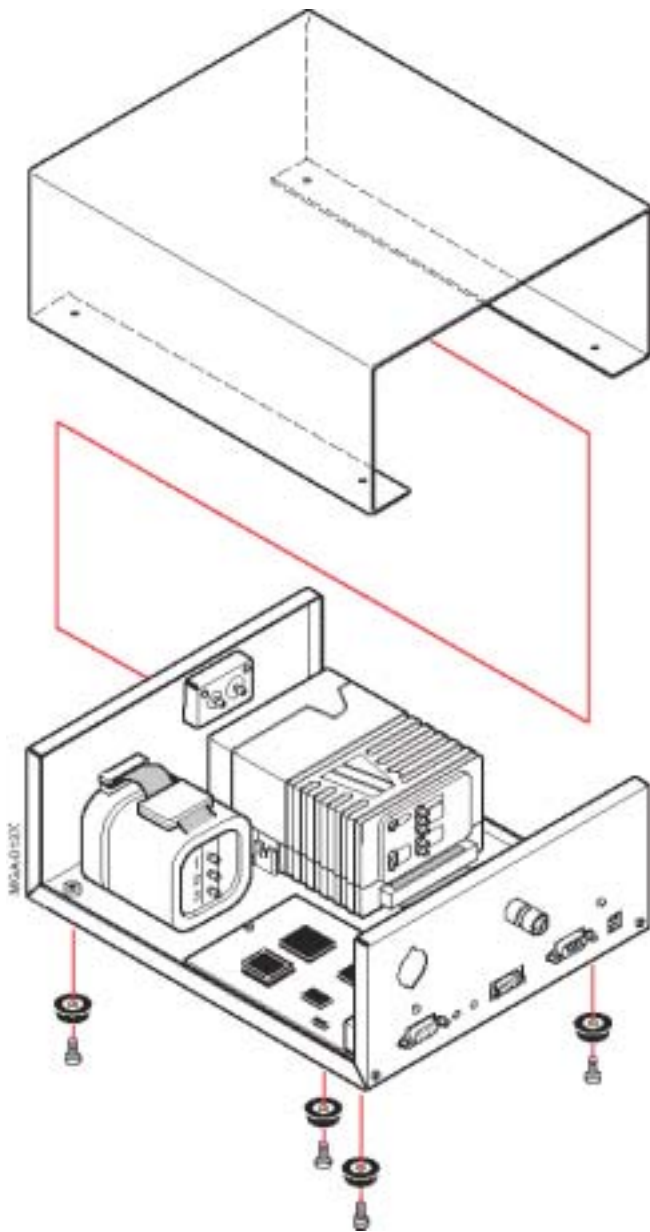
## 4.6 Cover

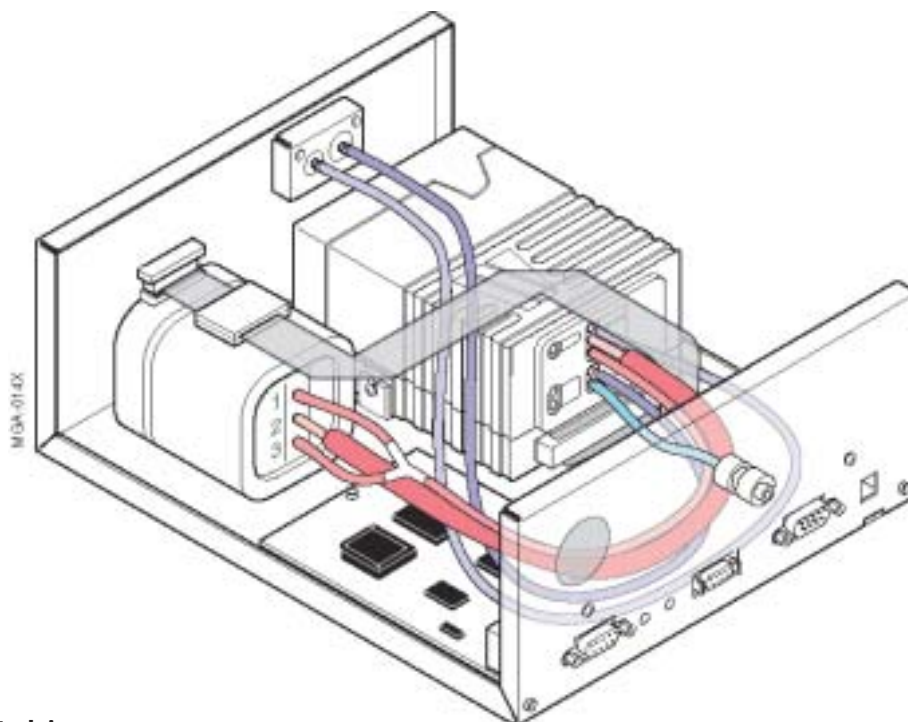
### 4.6.1 Disassembly

1. Unscrew the four screws.
2. Pull off the cover.

### 4.6.2 Assembly

Assembly is done in reverse order.





## 4.7 Internal tubing

### 4.7.1 Disconnection

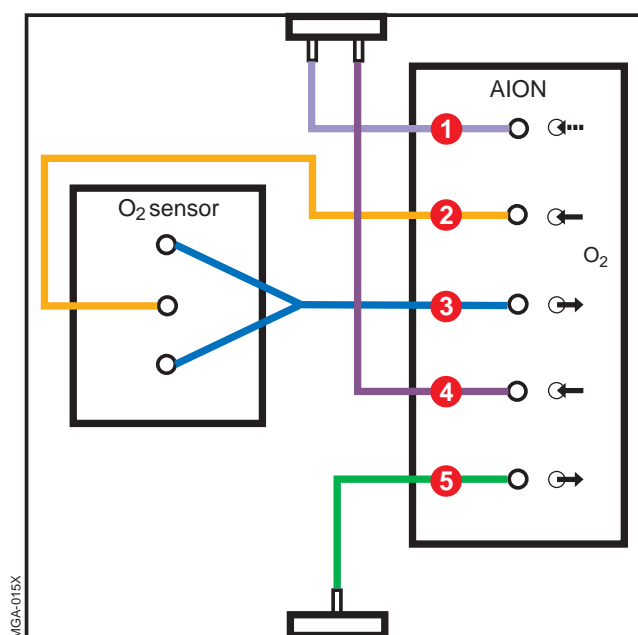
The tube (1) connected to the gas sample inlet on AION (having a silicon sleeves in both ends) should be disconnected by carefully pulling it off the connector.

**Note:** To protect all other connectors from damage when disconnecting the internal tubing, proceed as follows:

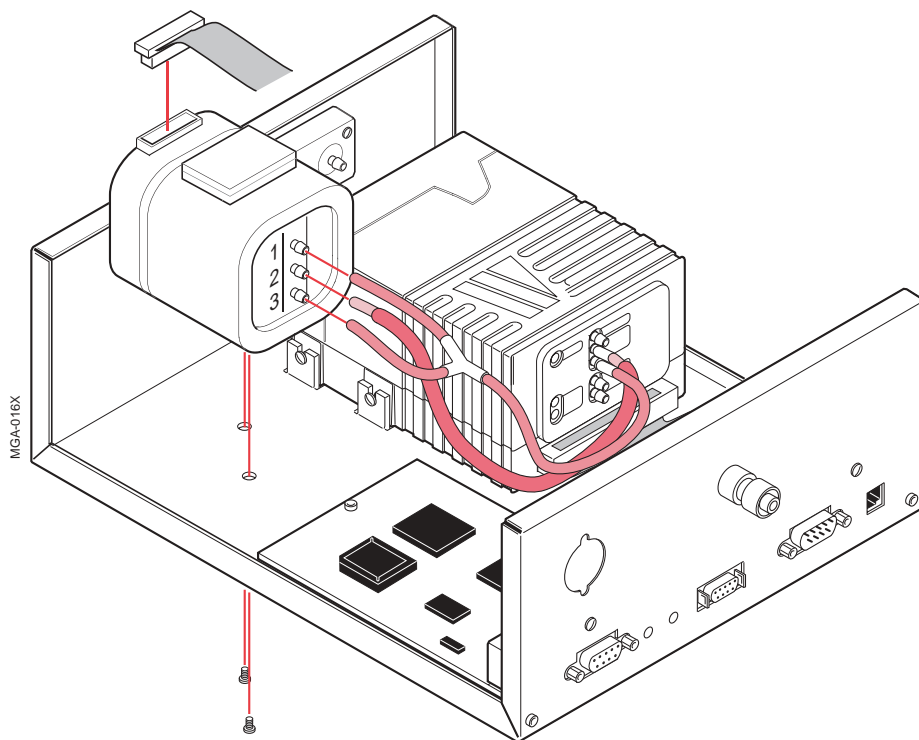
1. Use a wire cutter to cut the tube close to the connector.
2. Use a sharp knife, e.g. a scalpel, to remove the tube remains from the connector.
3. Do not re-use the cut tubes. The length of the tubes are important for correct functionality.

### 4.7.2 Connection

- The tubing connected to the water trap receptacle is factory mounted and must not be exchanged separately. See Water trap receptacle below.
- When fitting tubing on to nipples, push the tubing all the way to the base of the nipple to ensure tightness.
- Avoid kinks and small radius bends in the gas tubing. Tubing with a small radius bend may work well at room temperature but may become blocked at higher temperatures.



No.	Lenght	Connections
1	350 mm	Purge gas inlet
2	280 mm	From O <sub>2</sub> sensor
3	280 mm	To O <sub>2</sub> sensor
4	350 mm	Sampling gas inlet
5	110 mm	Evacuation outlet



The KMG 2000 Service Software is required to:

- Adjust the potentiometers on the O<sub>2</sub> sensor. If the KMG 2000 Service Software is not used, the measurement accuracy of the KMG 2000 will be outdated.
- Perform an O<sub>2</sub> sensor calibration if the O<sub>2</sub> sensor and/or the AION has been replaced.
- Update the O<sub>2</sub> sensor serial number stored in AION EEPROM if the O<sub>2</sub> sensor has been replaced.

## 4.8 O<sub>2</sub> sensor

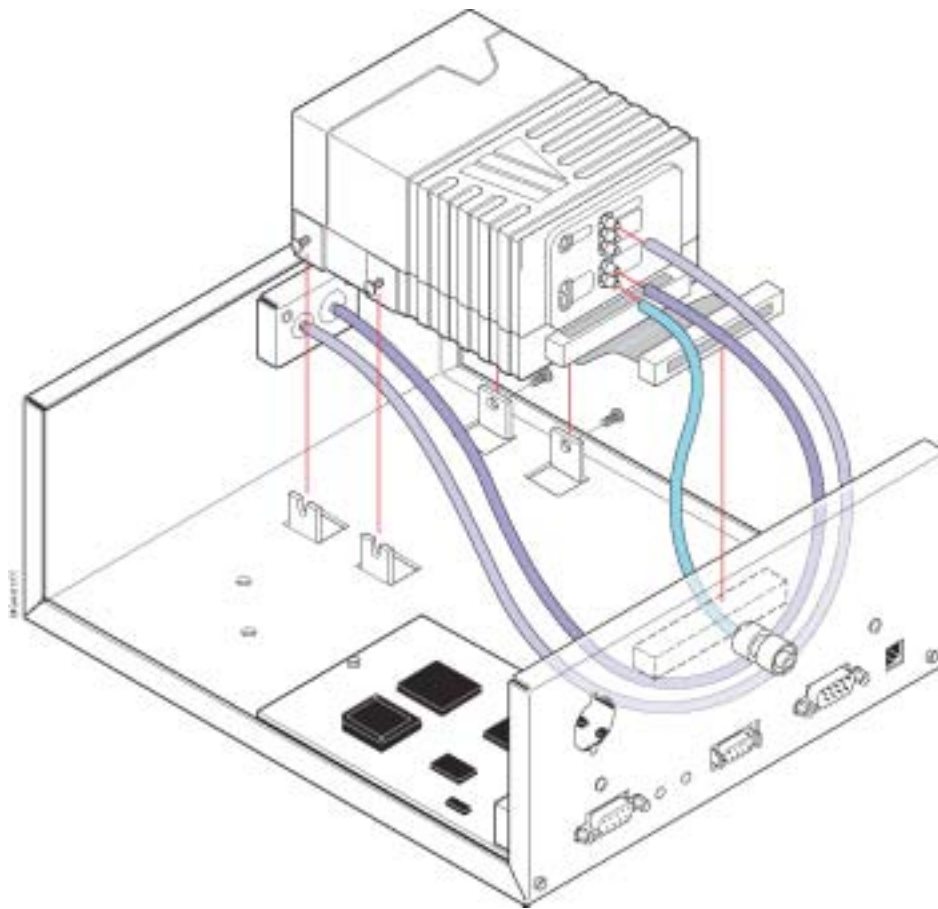
### 4.8.1 Disassembly

1. Remove the cover from the KMG 2000. See section Cover.
2. Cut the gas tubing. See section Internal tubing.
3. Disconnect the cable connector from the O<sub>2</sub> sensor.
4. Remove the two screws holding the O<sub>2</sub> sensor and lift off the O<sub>2</sub> sensor.

### 4.8.2 Assembly

Assembly is done in reverse order.

To mount the tubing, see section Internal tubing.



The KMG 2000 Service Software is required to:

- Perform an O<sub>2</sub> sensor calibration if the O<sub>2</sub> sensor and/or the AION has been replaced.
- Update the configuration stored in AION EEPROM if the AION unit has been replaced. This is done to secure traceability and to allow correct revision number to be shown on the KION Display.

## 4.9 AION

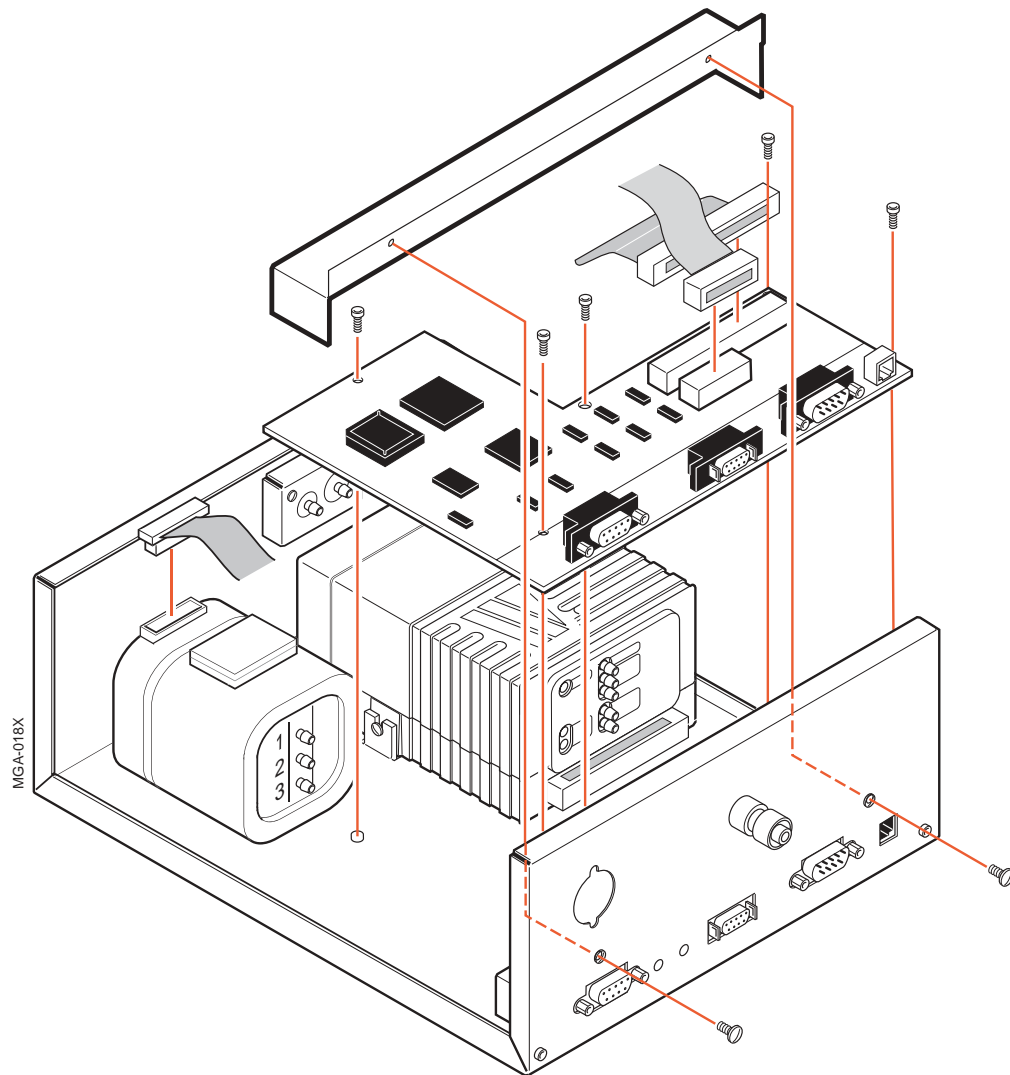
### 4.9.1 Disassembly

1. Remove the cover from the KMG 2000. See section Cover.
2. Remove the O<sub>2</sub> sensor. See section O<sub>2</sub> sensor.
3. Remove/cut the gas tubing. See section Internal tubing.
4. Disconnect the cable connector from SCM300 PC board.
5. Loosen the two inner screws holding the AION.
6. Remove the two outer screws holding the AION.
6. Lift off AION.

### 4.9.2 Assembly

Assembly is done in reverse order.

To mount the tubing, see section Internal tubing.



The KMG 2000 Service Software is required to:

- Update the SCM300 H/W revision and S/W version stored in AION EEPROM if the SCM300 board has been replaced.

## 4.10 SCM300 PC board with connectors

### 4.10.1 Disassembly

1. Remove the cover from the KMG 2000.  
See section Cover.
2. Remove the two screws on the rear panel holding the metal shield and lift off the metal shield.
3. Disconnect the two flat cable connectors from the SCM300 PC board.
4. Remove the five screws holding the SCM300 PC board.
5. Lift off the SCM300 PC board.

### 4.10.2 Assembly

Assembly is done in reverse order.

## 5. Service procedures

### 5.1 Functional verification

After any installation, maintenance or service intervention in the KMG 2000, perform a:

1. Leakage check
2. Gas measurement check.

If the KMG 2000 should fail in any of these checks, remedy the cause and repeat the test. The functional verification checks must be passed before the KMG 2000 can be released for clinical use.

### 5.2 Software installation

The following softwares can be downloaded in the flash memories via the connector P1:

- Protocol Converter Software (PrC-SW).
- Gas Analyzer Software (AION-SW)

#### 5.2.1 Tools

- Download program (Hitachi™ FLASH Development Tool kit). Included on the Software upgrade CD-ROM.
- TTY terminal software (e. g. HyperTerminal) on PC.
- Service cable (Siemens Order No. 47 14 346 E536U).

#### 5.2.2 Parts

- Software upgrade CD-ROM including download program.
- Software version label (sticker).

#### 5.2.3 FLASH Development Tool kit

- For installation, refer to information stored on the Software upgrade CD-ROM.
- For details about the FLASH Development Tool kit, see its built-in manual.

#### 5.2.4 Preparation

1. Connect the service cable between P1 on rear panel and the serial (COM) port on the PC.
2. Set the KION to Standby and start the PC.

#### 5.2.5 Protocol Converter Software (PrC-SW)

1. Push SW1 on the rear panel. LED lights up.
2. Start the download program.
3. In the *FLASH Development Toolkit* window, select *File menu*, item *Open* and load the *SCM\_V\_X\_X.MOT* included on the CD.
4. Select *Image menu*, item *Download image*.
5. In the *FLASH Controller* window Connection panel, set:
  - Select Interface = Direct Connection.
  - Select processor SH/7044F in Device selection.
  - Select appropriate COM port.
  - Set baud rate to 19200.
  - Select Connection = BOOT Mode.
6. Click on *Connect* under commands and wait until communication is established and verified with "Connection complete". If communication cannot be established, reduce baud rate to 9600 (or lower) and repeat step 6.
7. Click on *Download file*. The download starts and will continue several minutes.
8. Make sure that the download is verified with "Image successfully written to device".
9. Switch off the PC and disconnect the service cable.

Restart KION before use.

### 5.2.6 Gas Analyzer Software (AION-SW)

1. Push SW2 on the rear panel. LED lights up.
2. Start the download program.
3. In the *FLASH Development Toolkit* window select *File menu*, item *Open* and load the AION\_V\_X\_X\_X\_X.MOT included on the CD.
4. Select *Image menu*, item *Download image*.
5. In the *FLASH Controller* window Connection panel, set:
  - Select Interface = Direct Connection.
  - Select processor SH/7044F in Device selection.
  - Select appropriate COM port.
  - Set baud rate to 19200.
  - Select Connection = BOOT Mode.
6. Click on *Connect* under commands and wait until communication is established and verified with "Connection complete".  
If communication cannot be established, reduce baud rate to 9600 (or lower) and repeat step 6.
7. Click on *Download file*. The download starts and will continue a few minutes.
8. Make sure that the download is verified with "Image successfully written to device".
9. Switch off the PC and disconnect the service cable.

Restart KION before use.

### 5.2.7 Configuration update

Update the configuration stored in the AION EEPROM to allow correct revision to be shown on the KION Display.

The Configuration update can be performed in two ways:

- Using a PC with a terminal program as described below.
- Using the KMG 2000 Service Software.

Configuration update using a PC with a terminal program:

1. Start the KION.
2. Start TTY Terminal on the PC.
3. Adjust settings to 38400 baud, 8-bit, no parity, 1 stop bit
4. Type the command **d5** and press Enter. The SCM Menu will appear.
5. Select Change configuration (type **1** and press Enter). The actual configuration will be displayed together with the question: "Change configuration (Y/N)".
6. Type **Y** and press Enter.
7. Press Enter until "MGM SW NNNN" appears.
8. Enter new SW revision number (NNNN) and press Enter.
9. If PrC-SW was updated; press Enter until "SCM SW NN" appears. Enter new SW version number (NN) and press Enter
10. Press Enter until the question "Save new configuration (Y/N)" appears.
11. Type **Y** and press Enter. The new configuration is now saved.
12. Type **X** and press Enter to exit debug mode.

Update the software revision label on the rear panel of the KMG 2000.

1. Attach the new SW revision label included in the package at the SW revision label area on the rear panel of the KMG 2000.

Restart KION before use.



## 5.3 Calibrations and verifications

### 5.3.1 Recommended Tools and Equipment

- KION including KION Display (e.g. SC 7000 or SC 9000XL).
- Calibration gas kit including gas bottle, regulator and tubing. Siemens Order No. 52 07 415 E536U.
- Gas evacuation system for the calibration gas.
- Flowmeter, 0–400 sml/min with  $\pm 1.5\%$  accuracy or better. Recommended: Sierra Flow Control model 822-CE-RFQ-1801.
- Standard service tools:
  - Screwdriver
  - Wire cutter and needle nose plier.

### 5.3.2 Calibration setup

The calibration gas kit is required for the:

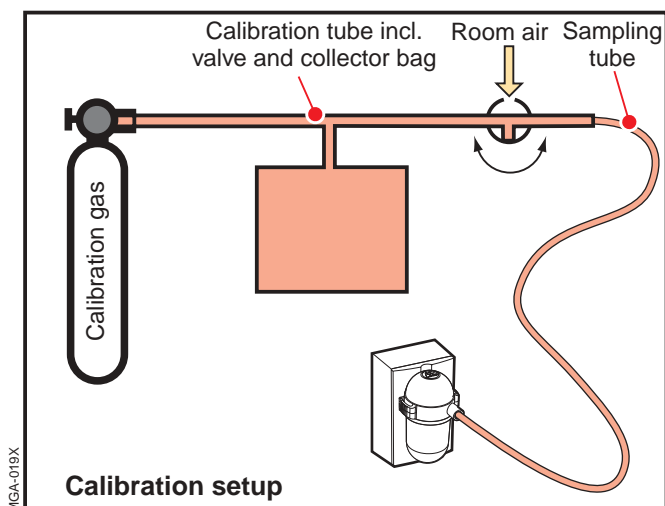
- Gas measurement check
- Gas span calibration
- Zero calibration valve check.

**Warning:** The calibration gas contains substances that may be detrimental to your health. During use of calibration gas, assure that the KMG 2000 is connected to an effective gas evacuation system, e.g. the hospital's EVAC system.

During calibration of the KMG 2000, different sampling flows are used (70 – 200 ml/min). This is automatically controlled by the KMG 2000. As the flow regulator on the calibration gas bottle is set to approx. 150 ml/min, the collector bag must be used as a gas reservoir to ensure sufficient calibration gas supply to the KMG 2000.

Supply calibration gas to the system as follows:

1. Connect the calibration gas equipment to the sampling tube as shown in the illustration.  
**Note:** Make sure that the 3-way-valve on the calibration tube is set to "room air".
2. Carefully open the calibration gas bottle valve to fill the collector bag with calibration gas.  
**Note:** Fill the collector bag carefully. The bag will not withstand high gas pressure.
3. When sufficient amount of calibration gas is collected in the bag, switch the 3-way-valve on the calibration tube to "calibration gas".
4. The calibration gas from the collector bag will now be supplied to the system. Adjust the calibration gas bottle valve to keep a sufficient amount of calibration gas in the collector bag during the calibration procedure.
5. When the calibration is completed, close the calibration gas bottle valve.
6. Allow the KMG 2000 to purge the gas in the calibration setup, including the collection bag, into the gas evacuation system.
7. Set the 3-way-valve to "room air".
8. Remove the calibration gas kit.





### 5.3.3 Leakage check

**Note:** Always perform a Leakage check before initiating any calibration or verification procedures.

To make a Leakage check on the KMG 2000, the rear cover on KION must be removed and the evacuation tube connected to the KMG 2000 must be disconnected.

Perform the Leakage check on the KMG 2000 unit with sampling tube and water trap connected.

1. Connect the flowmeter to the evacuation outlet on the rear panel of the KMG 2000.
2. Power-up the system.
3. Verify that the value on the flowmeter is 200 ml/min  $\pm$  20 ml/min (or 120 ml/min  $\pm$  12 ml/min if the flow rate setting is set to 120).
4. Occlude the sampling line inlet by using your fingertip.
5. Verify that the value on the flowmeter decreases to 0  $\pm$  10 ml/min.

If the leakage acceptance requirements are not fulfilled, check the pneumatic system carefully for leaks and damaged tubing. The Leakage check must then be repeated.

### 5.3.4 Gas measurement check

**Note:** Always perform a Leakage check before starting the Gas measurement check. Refer to 5.3.3 Leakage check.

**Warning:** The calibration gas contains substances that may be detrimental to your health. During the Gas measurement check, assure that the KMG 2000 is connected to an effective gas evacuation system, e.g. the hospital's EVAC system.

Proceed the check as follows:

1. Verify that you operate the KMG 2000 within its specified operation temperature, humidity and atmospheric pressure (See the User's manual).
2. Connect a water trap and a sampling tube.
3. Power-up the KION system and let it stabilize for at least 10 min or until the displayed text "Multigas warming up" disappears.
4. On the KION Display, set the sampling flow rate to 120 ml/min. Refer to the User's manual.
5. Connect the calibration gas kit. Refer to 5.3.2 Calibration setup.
6. Supply calibration gas to the system. Refer to 5.3.2 Calibration setup.
7. Wait 30 s for stabilization.
8. Check that the displayed values are within the specifications as stated below (accuracy of the calibration gas included):

Gas	Min [%]	Max [%]
CO <sub>2</sub>	4.1	5.9
O <sub>2</sub>	47.7	56.3
N <sub>2</sub> O	36.2	43.8
Isoflurane	2.54	3.46

9. If the displayed values are within these specifications, the Gas measurement check passed.

If the displayed values are outside these specifications, perform a Gas span calibration.

Close the calibration gas bottle valve and follow the procedure for purging and removing the calibration gas kit. Refer to 5.3.2 Calibration setup.

### 5.3.5 Zero calibration valve check

**Note:** Always perform a Leakage check before starting the Zero calibration valve check. Refer to 5.3.3 Leakage check.

**Warning:** The calibration gas contains substances that may be detrimental to your health. During the Zero calibration valve check, assure that the KMG 2000 is connected to an effective gas evacuation system, e.g. the hospital's EVAC system.

Proceed as follows:

1. Verify that you operate the KMG 2000 within its specified operation temperature, humidity and atmospheric pressure (refer to the KION Display User's manual).
2. Connect a water trap and a sampling tube.
3. Power-up the KION system and let it stabilize for at least 10 min or until the displayed message "Multigas warming up" disappears.
4. Connect the calibration gas kit. Refer to 5.3.2 Calibration setup.
5. On the KION Display, access Service menu and enter Biomed password (4712). Refer to the KION Display User's manual.
6. Select Calibration
7. Supply calibration gas to the system. Refer to 5.3.2 Calibration setup.
8. Wait 15 s for stabilization.
9. Select MGM Calibration
10. Wait for message "Multigas zero accepted"
11. Press the Main Screen key to abort the calibration sequence.
12. Verify that the displayed values are within the specifications stated below (this includes the accuracy of the calibration gas):

Gas	Min [%]	Max [%]
CO <sub>2</sub>	4.1	5.9
O <sub>2</sub>	47.7	56.3
N <sub>2</sub> O	36.2	43.8
Isoflurane	2.54	3.46

13. If the displayed values are within these specifications, the Zero calibration valve check passed.

If the displayed values are outside these specifications, the Zero calibration valve check failed. Replace the AION.

Close the calibration gas bottle valve and follow the procedure for purging and removing the calibration gas kit. Refer to 5.3.2 Calibration setup.

### 5.3.6 Gas span calibration

This procedure must be performed only if the Gas measurement check shows that the unit is outside the gas measurement specifications.

During Gas span calibration, a calibration gas with accurately known gas concentrations is introduced into the KMG 2000 gas sampling system. If there are differences between the measured and expected values, span calibration factors are stored in the AION EEPROM and the measured values will be compensated by these factors.

**Note:** Always perform a Leakage check before starting the Gas span calibration. Refer to 5.3.3 Leakage check.

**Warning:** The calibration gas contains substances that may be detrimental to your health. During the Gas span calibration, assure that the KMG 2000 is connected to an effective gas evacuation system, e.g. the hospital's EVAC system.

Proceed as follows:

1. Verify that you operate the KMG 2000 within its specified operation temperature, humidity and atmospheric pressure (refer to the KION Display User's manual).
2. Connect a water trap and a sampling tube.
3. Power-up the KION system and let it stabilize for at least 10 min or until the displayed message "Multigas warming up" disappears.
4. Connect the calibration gas kit. Refer to 5.3.2 Calibration setup.
5. On the KION Display, set the sampling flow rate to 120 ml/min. Refer to the KION Display User's manual.
6. On the KION Display, select the Agent parameter box to bring up the Agent menu. Refer to the KION Display User's manual.
7. Check that ID Override is set to OFF.
8. Access Service menu and enter Biomed password (4712).
9. Select MultiGas (MGM) Calibration.  
Note: The path to select MGM calibration differs between the KION Display software versions.
10. When message "Supply Gas Mixture and then Press Continue" displays, supply calibration gas to the system. Refer to 5.3.2 Calibration setup.
11. Wait 30 s for stabilization.
12. Select "Continue".
13. Wait for the message "PASS". The calibration is finished.
14. Press the Main Screen key to return to the main screen.
15. Close the calibration gas bottle valve and follow the procedure for purging and removing the calibration gas kit. Refer to 5.3.2 Calibration setup.

### 5.3.7 Gas zero calibration

Gas zero calibration of the KMG 2000 is automatically performed by the Zero calibration valve. For further information, refer to chapter "Description of functions", section "AION".

### 5.3.8 O<sub>2</sub> sensor calibration

As the O<sub>2</sub> sensor is flow-sensitive, the AION and the O<sub>2</sub> sensor must be calibrated together. The O<sub>2</sub> sensor calibration must be carried out when either of the two units are replaced.

The O<sub>2</sub> sensor calibration requires KMG 2000 Service Software.

## 5.4 KMG 2000 Service Software

The KMG 2000 Service Software, run on a PC connected to the KMG 2000, will enable a number of service and troubleshooting options.

The KMG 2000 Service Software will e. g. display:

- Status for the different sub-units
- Error logs
- Error log frequency
- Messages from the KMG 2000.

The KMG 2000 Service Software is required to:

- Update the configuration stored in the AION EEPROM if the AION unit has been replaced. This is done to secure traceability and to allow correct revision number to be shown on the KION Display.
- Perform an O<sub>2</sub> sensor calibration if the O<sub>2</sub> sensor and/or the AION has been replaced.
- Adjust the potentiometers on the O<sub>2</sub> sensor. If the KMG 2000 Service Software is not used, the measurement accuracy of the KMG 2000 will be outdated.
- Update the O<sub>2</sub> sensor serial number stored in AION EEPROM if the O<sub>2</sub> sensor has been replaced.
- Update the SCM300 H/W revision and S/W version stored in AION EEPROM if the SCM300 board has been replaced.

Instructions for the KMG 2000 Service Software is included in the software package.

## 6. Troubleshooting

### 6.1 General

Before you start any troubleshooting, begin if possible by questioning the person reporting the fault. Ask how the fault appeared.

Make sure that there has been no operating error.

There should be a logical trend to your troubleshooting. First try to trace the faulty function. Then the most suitable procedure is to track down the exact fault by systematically replacing individual spare parts, one at a time.

One purpose of the Description of functions and the Diagrams in this Service Manual is to make it easier to trace faults.

Before any KION or KMG 2000 cover is removed, make sure that the mains power supply is disconnected.

With mains power supply connected to the unit, there are energized electrical components inside the equipment. All personnel must exercise extreme caution when in the vicinity of this equipment if fault tracing or adjustments are performed with mains power supply connected and covers removed.

After any service intervention in the KION System, perform a Function check according to instructions in the Operating Manual.

### 6.2 Problem identification

Technical problems with the KMG 2000 can be divided in two main groups:

- No communication established between the KION Display and the KMG 2000. Troubleshooting is described in section 6.4 Communication.
- Problem with the information created by the KMG 2000 (wrong CO<sub>2</sub>, O<sub>2</sub> or agent concentration, long rise or response time, message "MultiGas data invalid" on the KION Display). Troubleshooting is described in section 6.5 Inaccurate information.

### 6.3 Prior to troubleshooting

Prior to any troubleshooting:

1. Check that the sampling line and the water trap are correctly mounted.
2. Check that the sampling gas tube, the purge gas tube and the evacuation tube are correctly connected to the KMG 2000.

### 6.4 Communication

Set the KION to Standby and wait until the text "KMG 2000 Warming Up" is displayed on the KION Display.

Check if communication between the KION Display and the KMG 2000 is established as follows:

1. Remove the water trap. Check that the message "MultiGas data invalid" appears on the KION Display.
2. Connect the water trap. Check that the message "MultiGas data invalid" disappears on the KION Display.

If communication is not established, proceed as follows and repeat the communication test after each action:

3. Check the electrical connection between the water trap receptacle and the KMG 2000. If an extra water trap receptacle is available, connect it to the KMG 2000 and repeat the communication tests. Replace the water trap receptacle if necessary.
4. Check the RS232 communication between the KMG 2000 and the KION Display. Check connectors, cables, etc.
5. Check the power supply to the KMG 2000. Check connectors, cables, etc.
6. Check electrical connections inside the KMG 2000. Replace cables if necessary.
7. Replace the SCM300 PCBoard. KMG 2000 Service Software is required.
8. Replace the AION. KMG 2000 Service Software is required.

## 6.5 Inaccurate information

### 6.5.1 Leakage

1. Perform a Leakage check, refer to chapter "Service procedures".

If the Leakage check passed, go to section 6.5.2 Gas measurement.

If the Leakage check failed, proceed as follows and repeat the Leakage check after each action:

2. Replace the water trap and the sampling line
3. If an extra water trap receptacle is available, connect it to the KMG 2000 and repeat the Leakage check. Replace the water trap receptacle if necessary.
4. Check all internal tubings inside the KMG 2000. Replace tubings if necessary.
5. Replace the AION.  
KMG 2000 Service Software is required.
6. Replace the O<sub>2</sub> Sensor.  
KMG 2000 Service Software is required.

### 6.5.2 Gas measurement

1. Perform a Gas measurement check, refer to chapter "Service procedures".

If the Gas measurement check passed, the system is functional and no further troubleshooting is necessary.

If the Gas measurement check failed, go to section 6.5.3 Gas span.

### 6.5.3 Gas span

1. Perform a Gas span calibration, refer to chapter "Service procedures".

If the Gas span calibration passed, the system is functional and no further troubleshooting is necessary.

If the Gas span calibration failed, proceed as follows and repeat the Gas span calibration after each action:

2. Replace the AION.  
KMG 2000 Service Software is required.
3. Replace the O<sub>2</sub> Sensor.  
KMG 2000 Service Software is required.

## 7. Preventive maintenance

The KMG 2000 must be serviced at regular intervals by personnel trained and authorized by Siemens. Any maintenance or service must be noted in a log book.

Preventive maintenance must be performed at least once every year as long as the unit is not used more than normal. Normal operation is estimated to correspond to approx. 5.000 hours of operation.

As the KMG 2000 is an integrated part of the KION System, preventive maintenance of the KMG 2000 and the KION should be performed at the same time.

It is recommended that maintenance and service is done as a part of a service contract with Siemens.

### 7.1 Performing the Preventive maintenance

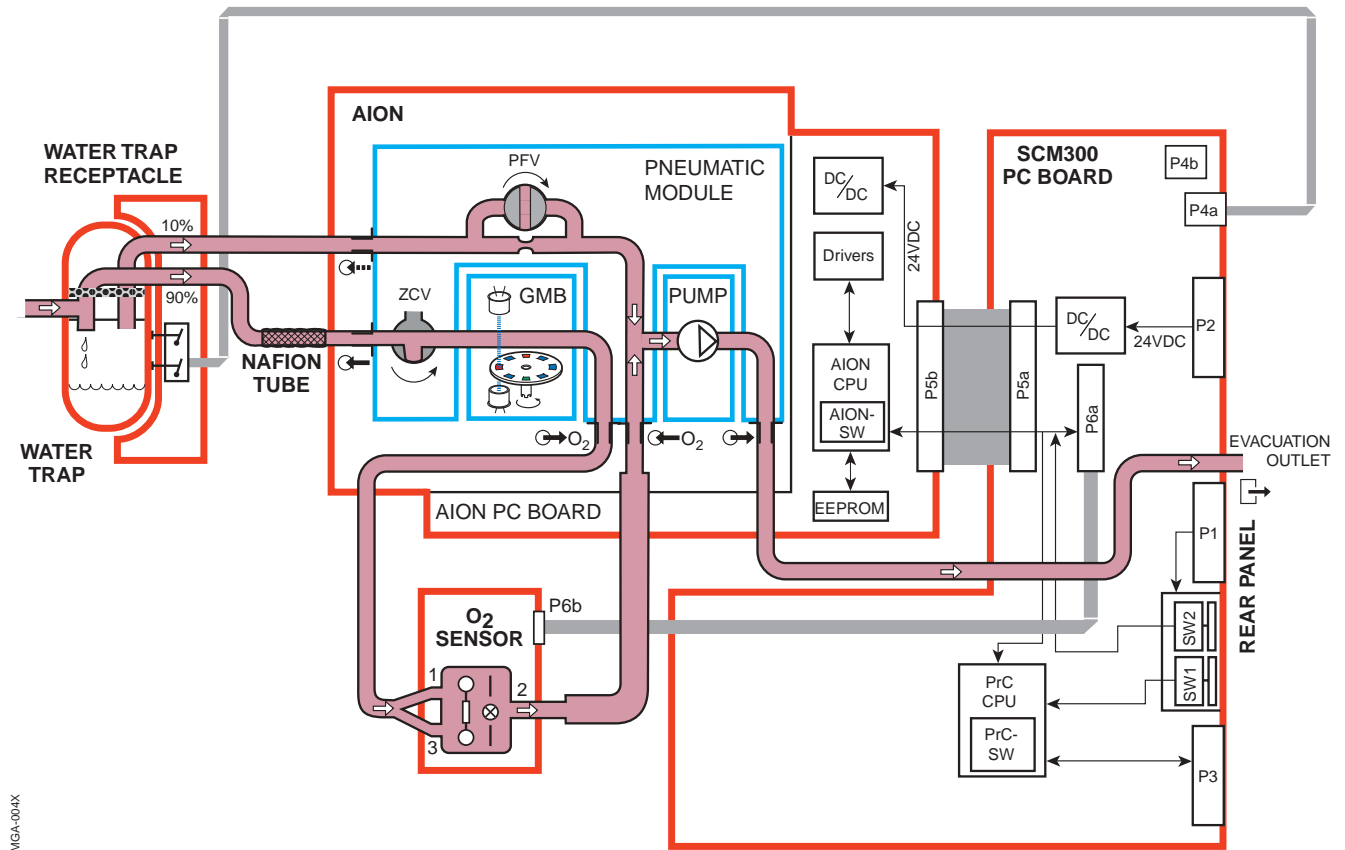
- Replace the water trap receptacle including tubing. Refer to chapter Disassembly and assembly.
- Replace the water trap and sampling line.
- Perform a Leakage test. Refer to chapter "Service procedures".
- Perform a Gas measurement check. Refer to chapter "Service procedures".
- Perform a Zero Calibration Valve test. Refer to chapter "Service procedures".
- A Pre-use check of the KION System must be performed before connecting the system to a patient.

## Notes

[illegible]

## 8. Diagrams

### 8.1 Functional block diagram



MGA-004X

KION MultiGas 2000 – Service Manual  
Order No.: 65 43 040 E392E

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